CS342 - Numerical Analysis and Computational Methods - Group Project

Objective

To deepen understanding of numerical methods by implementing algorithms, analyzing their convergence, accuracy, and efficiency. Students will code, test, and evaluate numerical methods from the Numerical Analysis book by Burden (10E).

Methods Covered

- 1. Bisection Method
- 2. Fixed Point Iteration
- 3. Newton's Method
- 4. Secant Method
- 5. Lagrange Interpolation
- 6. Hermite Interpolation
- 7. Cubic Spline Interpolation
- 8. Parametric Curves
- 9. Numerical Differentiation
- 10. Richardson Extrapolation
- 11. Numerical Integration (Trapezoidal, Simpson's)
- 12. Romberg Integration
- 13. Gaussian Elimination and Variants
- 14. Pivoting Strategies
- 15. Matrix Factorization (LU, Doolittle, Crout, Cholesky)

Group Tasks

Each group (5 students) will do all of the above methods. For each method, they will:

- Implement the algorithm from scratch.
- Apply it on at least three test examples.
- Record results in tabular format (e.g., iterations, approximation, error).
- Count the total number of iterations until the stopping criterion is met.
- For interpolation/integration, compare with exact/known value.
- Bonus: Plot graphs (e.g., error vs. iterations, interpolated curve).

Deliverables

- Code for all methods (.py, .ipynb, .m, etc.)

- Project Report (PDF) containing:
  - Method overview
  - Explanation of the code
  - Tables of results
  - Graphs (if applicable)
  - Interpretation of results
- Group Contribution Sheet: Who did what.

Report Format Sample

Method: Newton-Raphson

Function used: f(x) = x^3 - 4x + 1
Initial Guess: $x_0 = 1$
Iteration	x□	f(x□)	Error
1	…	…	…
...

Total Iterations: ...
Stopping Tolerance: 1e-6

Conclusion: Newton's method converged in 5 iterations, error reduced rapidly...

Grading Rubric (Total: 9 Marks)

Category	Marks	Description
Correct Code Implementation	3	Accurate logic and syntax; passes test cases
Iteration & Error Analysis	2	Shows convergence process clearly; accurate error tracking
Report Quality & Explanation	2	Well-explained steps, tables, interpretations
Code Quality & Documentation	1	Clear, commented code; structured with functions where needed

Bonus: Visualization (Graphs)	+1	Error convergence plots, interpolated curves, spline plots, etc. (optional)

Timeline & Notes

- Deadline: May 05, 2025 till 5 pm
- Plagiarism = Zero marks
- Oral Viva or project presentations will be conducted on May 6 and May 7, 2025. All group members must be present and prepared to discuss any part of the assigned methods. Marks are adjusted based on individual understanding and contribution.